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Evaluation of the economic development of European Union countries

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Abstract. In the European Union (EU), as a global economic community, there are countries with very different levels of economic development. Therefore, it takes place unevenly – some countries develop intensively, but with significant changes in it, others – stably, without significant changes, but not intensively, etc. In such a situation, it is important to determine adequately the current state of economic development. It is an integral quantity that combines both development changes and intensity. These two components of development form two of its partial indicators. Combined into one size, they comprehensively reflect the current situation of the country's economic development. Development refers to a process, so it must be assessed not on the basis of the state at the end of the period under consideration, but on the whole of this period. The presentation of development in the sense of recent years does not reflect the overall development process, based on the economic development of countries 2018–2022. Their ranks are determined by the results of the comprehensive assessment. Since they do not adequately reflect the current situation, the countries were combined into homogeneous groups, where countries with close values of the economic development indicator were located. This allows to highlight the economic development trends of EU countries.

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1. INTRODUCTION

The European Union (EU), as an economic community, was formed over a rather long period – since 1950 and continues to develop. In the first stage of its formation, the most economically developed European countries – Ireland, Denmark, Luxembourg, Holland and others – joined together. Later on, less economically developed countries – Bulgaria, Poland, Romania, Hungary and others – joined the EU. For example, Luxembourg's gross domestic product per capita (GDP), which reflects the state of the country's

economic development, in 2022 was over 9.6 times, Ireland – about 8 times, the Netherlands – about 5.2 times and Denmark – about 4.4 times the GDP of Bulgaria (Eurostat, 2022). In such a heterogeneous economic community, the whole series of essential questions for its further development arise – what are the development trends of it as an economic community as a whole and of its individual members, how being part of it has affected the development of both economically developed and developing countries, etc. The answer to these questions is ambiguous. It is more difficult for the most developed countries to maintain high rates of economic development than for developing countries. This is reminiscent of the situation of athletes – jumpers. They add centimeters relatively easily up to a certain limit. After that, each additional centimeter requires significantly more effort. The situation of developing countries is the opposite – after joining the EU, they "started" from significantly lower positions. In addition, they have adopted the latest methodologies and therefore their results can grow much faster. This situation facilitates the answer to the question of how to adequately measure the economic development process of EU countries. It is possible to refer to the level achieved at the end of the considered period, e.g. in 2022. However, in this case, the development context – the intensity of development changes – will remain underestimated. We are faced with a contradictory situation. The pace of development of countries with high economic development may be low, while the pace of development of other, on the contrary, much less economically developed countries may be high. The question is, which of them is in better situation? Now, it is found every year by presenting the country's economic development indicator (Eurostat, 2022). Perhaps such an assessment is one-sided, since foreign investment flows and the arrival of foreign companies largely depend on the pace of development of a country, especially an economically developing one, since it is in this case that a large part of successful business opportunities are created.

In order to carry out an analysis of such a situation and adequately assess the current situation, it is appropriate to rely on information from international statistical databases about the economic development of countries during the considered period and evaluate it comprehensively, i.e. both the current state of development and the intensity of development.

The aim of the article is to propose a methodology for quantitative assessment of the economic development of EU countries, which adequately assesses both its condition and the intensity of development during the considered period.

2. LITERATURE REVIEW

In order to evaluate the state of economic development of the countries, first of all, it is necessary to establish a reasoned indicator that reflects it. This task is complicated by the fact that such an indicator should combine the effects of practically all essential factors of economic development. It is an integral result of the commercial and economic activities of the country's economic entities. In theory and practice, two principle approaches to solving this problem can be seen. In one case, the state of the country's economic development at the end of the considered period is determined based on an index that combines the aforementioned aspects (Moldan et al., 2012; Brizga et al., 2014; Jędrzejczak-Gas, Barska, 2019; Kozyreva et al., 2017). Otherwise, first of all, a set of indicators is formed that reflect individual components of economic development. After that, they are combined into one summarizing size (Radovanović, Lior, 2017; Jis et al., 2017; Bolcarova, Kološta, 2015; Chursan, 2013; Babu, Datta, 2015). So, in the first case, one follows the path of induction, in the second, the path of deduction. A deeper analysis shows that each of these approaches has both strengths and weaknesses.

Today, gross domestic product per inhabitant is unanimously accepted as an indicator that reflects the state of the country's economic development in an integrated manner (Habánik et al., 2021; Oliinyk et al., 2021; Roshchyk et al., 2022). Its strengths are manifested in the following aspects: first, it is calculated

according to a unified methodology in all countries, and therefore it is possible to compare countries with each other based on it; secondly, GDP appears as one of the most important indicators in almost all proposed systems of economic development indicators of countries; thirdly, it is sufficiently complex, as it combines many essential results of economic activity, both branch and territorial; fourth, information about this index is easily available in both national and international statistical databases (Li et al., 2018; Singh et al., 2012; Gedvilaitė, 2019; Boggia et al., 2014; Becker et al., 2017; Verbunt, Rogge, 2018). Based on this, it is claimed that GDP adequately reflects the state of the country's economic development (Androniceanu et al., 2021; Čiegis et al., 2010; Gaspareniene et al., 2022; Moldan et al., 2012; Jędrzejczak-Gas, Barska, 2019).

The strengths of the second method of quantitative assessment of the country's economic development state are manifested in the fact that it provides greater opportunities for assessment adequacy. This is because the overall process of the country's economic development is broken down into the desired number of aspects that reflect it. After turning them into indicators, a comprehensive system of indicators is formed, based on which it is possible to find a complex size that sufficiently accurately reflects the current state of development. On the other hand, the experience of applying this method has also revealed its shortcomings, which significantly limit the possibilities of its wider application. They are manifested in the following aspects: first, international databases do not provide information about the values of all desired indicators. Literature sources even indicate that, for this reason, a part of sufficiently important indicators is turned off from their system and, in this way, the adequacy of the assessment is reduced (Golusin, Munitlak, 2009). Secondly, the systems of indicators for the quantitative assessment of the state of economic development applied in individual countries differ both in their number and in their composition. This makes comparisons between countries impossible. Third, high calculation costs, primarily because the importance of indicators is determined exclusively by expert evaluations. In addition, it increases the subjectivity of the assessment. Fourth, the indicators can be combined into one summarizing value only by applying complex multi-criteria evaluation methods (Trishch et al., 2021; Cherniak et al., 2020; Ginevičius et al., 2022; Trishch et al., 2023).

For all these reasons, this method of quantitative assessment of the state of economic development of countries is applied only in individual countries. International estimates are based on GDP per capita (Eurostat, 2022).

The other aspect of countries' economic development is its intensity during the considered period, so it does not reflect its state, but the development process. Therefore, to assess the intensity quantitatively, it is necessary to compare the values of economic development at the end and the beginning of the considered period in an appropriate way. The greater this difference, the greater the intensity of development. There are few literature sources that deal with this aspect of economic development. In one case, the development intensity is determined as the ratio of the above values (Ginevičius et al., 2018):

$$D_j = \frac{Q_{fj}}{Q_{bj}}, \tag{1}$$

here D_j is the intensity of economic development of the *j*-th country; Q_{fj} – the significance of the economic development of the *j*-th country at the end of the considered period; Q_{bj} – the same, at the beginning.

Otherwise, the significance of the country's economic development is normalized, i.e. a coefficient that varies from zero to one is determined (Ginevičius et al., 2018):

$$\widetilde{D}_j = \frac{Q_{fj} - Q_{bj}}{Q_{fj}}, \tag{2}$$

here $\widetilde{D}_j$ is the economic development intensity coefficient of the *j*-th country.

It can be seen from formulas (1) and (2) that in both cases the value of the intensity of economic development of the country at the end of the considered period Q_{fj} does not evaluate the changes that took place during it, i.e. refers to the condition rather than the process as a whole. Thus, both the nature and extent of the changes that took place during the considered period are underestimated.

3. METHODOLOGY OF INVESTIGATION

In order to comprehensively assess the country's economic development, it is necessary to know both its condition and intensity indicators. From the literature review, it can be seen that it is appropriate to accept GDP per capita as a condition indicator. In order to determine the intensity of development, it is necessary to know the values of its condition both at the beginning Q_b and at the end of the considered period Q_f. On the other hand, they underestimate the nature and extent of the changes that have taken place at the moment. Meanwhile, it is an important condition for an adequate assessment of development. This is clearly shown in Fig. 1.

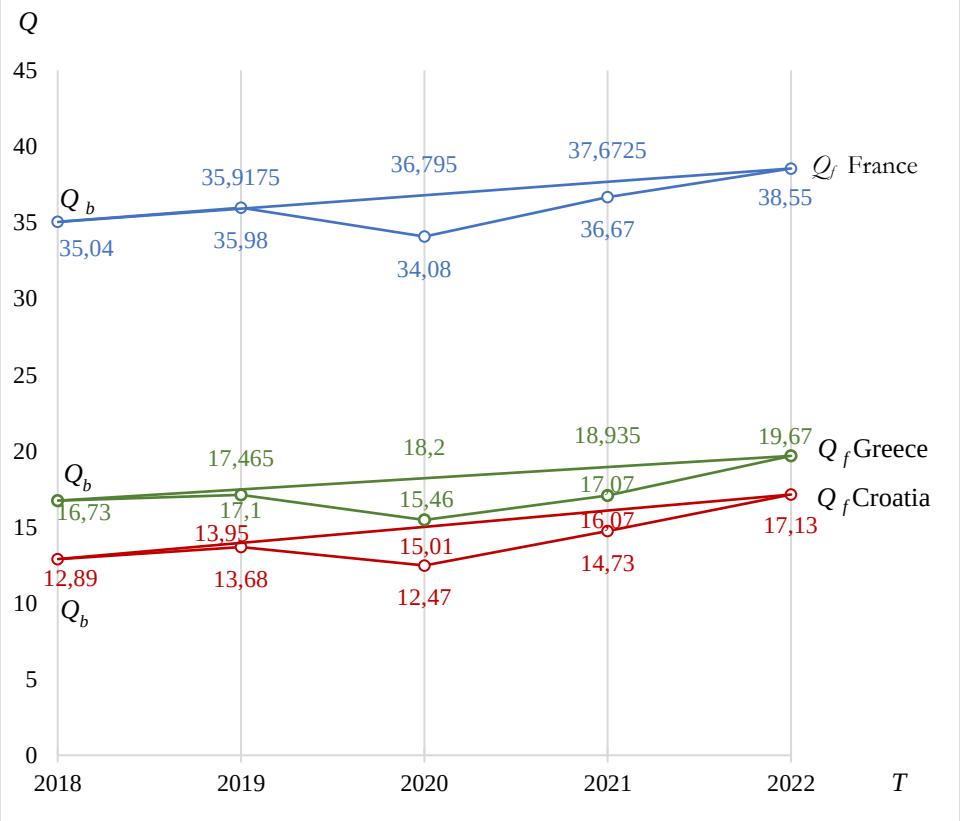

Figure 1. Economic development of the examined countries of the European Union in 2018–2022

Based on Figure 1, several conclusions important for development evaluation can be made. First, the values of economic development at the beginning and end of the considered period do not reflect the overall process. Second, there are large differences between countries in the state of economic development. Thirdly, the development of individual time periods of the considered period differs both in nature, i.e. it can be positive or negative, both in magnitude, i.e. in size. Fourth, some countries may have a high level of

economic development, but a low intensity of development (France, Greece), while others, on the contrary, have a low level of economic development, but a significantly higher intensity of development (Croatia).

Based on the results of individual time periods of the economic development of the countries under consideration, first of all, the total amount of positive and negative changes is determined:

$$P_j^+ = \sum_{i=1}^{P}\left(q_{ji+1}^+ - q_{ji}^+\right); \quad (3)$$

$$P_j^- = \sum_{i=1}^{l}\left(q_{ji+1}^- - q_{ji}^-\right), \quad (4)$$

here P_j^+ – the summary value of positive changes in the economic development of the *j*-th country during the considered period; P_j^- – the same, negative changes; q_{ji}^+ – the size of the positive changes of the *i*-period of the considered time of the *j*-th country; q_{ji}^- – the same, negative changes.

Sizes P_j^+ do P_j^- not measure the number of time periods during which positive or negative changes occurred. This can be done in the following way:

$$N_j^+ = \frac{t_j^+}{T}, \quad (5)$$

$$N_j^- = \frac{t_j^-}{T}, \quad (6)$$

here N_j^+ – a measure that evaluates the comparative weight of the time periods of the considered period of the *j*-th country, during which positive development changes took place; N_j^- – the same negative development; t_j^+ – the number of time periods of the considered period of the *j*-th country during which positive development changes took place; t_j^- – the same, negative development changes; *T* – the total number of time periods of the considered period.

It is easy to notice that $N_j^+ + N_j^- = 1.0$.

Based on the values N_j^+, N_j^- it is possible to calculate a coefficient that reflects the general picture of development changes that took place during the considered period:

$$K_j = \frac{N_j^+ + N_j^-}{N_j^+}, \quad (7)$$

here K_j is the coefficient reflecting changes in the economic development of the *j*-th country.

Now it is possible to find the adjusted value of the state of economic development of the country at the end of the considered period $\tilde{Q}_{jf}$:

$$\tilde{Q}_{jf} = K_j \cdot Q_{jf}. \quad (8)$$

Analogously, the adjusted size Q_b value is found $\tilde{Q}_b$.

We will determine the intensity of the countries' economic development during the considered period in the following way:

$$L_j = \frac{\tilde{Q}_{jf}}{\tilde{Q}_{jb}}, \quad (9)$$

here L_j – the intensity of economic development of the *j*-th country during the considered period; $\tilde{Q}_{jb}$ – the adjusted value of the state of economic development of the *j*-th country at the beginning of the considered period.

Knowing the significance of the state of economic development of the countries $\tilde{Q}_{jf}$, as well as the intensity L_j, it is possible to determine its general P_j size:

$$P_j = L_j \cdot \tilde{Q}_{jf}. \tag{10}$$

Based on size, P_j all the countries can be ranked. On the other hand, a deeper analysis shows that the ranking of countries based on ranks can be misleading, since the values of economic development indicators of countries can differ significantly less than the given rankings. For example, the indicator values between Spain and Hungary P_j differ by only 0.97 percent, while Hungary ranks 24 and Spain ranks 22; The economic development indicators of Finland and Sweden differ by as much as 12 percent, while their ranks are 7 and 4, respectively. All this means that it is appropriate to combine the countries into homogeneous groups (Trishch et al., 2021). The size of the grouping interval depends on the number of groups selected. In the case under consideration, it is appropriate to distinguish three groups. The first would include the countries with the worst economic development situation, the third – the best and the second – average. In this case, the size of the grouping interval can be determined in the following way (Tarka, Olszewska, 2018; (Bąk et al., 2002):

$$h = \frac{\tilde{Q}_{jf}^{max} - \tilde{Q}_{jf}^{min}}{3}, \tag{11}$$

here h is the size of the interval for grouping countries according to their economic development; $\tilde{Q}_{jf}(\tilde{Q}_{jf}^{min})$ – the value of economic development of the country for which it is the largest (smallest).

Before clustering, the most outliers should be removed from the statistical population, as they will distort the clustering results. This can be done based on the Romanovskii method (Kolker, 1976). Its essence is that two characteristics of the considered process are determined – the arithmetic mean $\bar{Q}$ and the mean square deviation *S*. This method was chosen because it is easily applicable. In addition, if one value is excluded from the statistical population, there is no need to recalculate the characteristics $\bar{Q}$ and *S*.

In order to remove or leave the considered value, the quantity *r* is calculated:

$$r = \frac{\bar{Q}_f - Fx_i}{S}, \tag{12}$$

here is Fx_i – the *i*-th value of the statistical population.

The obtained *r* value is compared with the table value r^* (Table 1).

Table 1

Size r^* values depending on the size of the statistical population

The size of the statistical population	20	25	30	40	50	120
r^*	2.14	2.10	2.08	2.05	2.02	1.99

Source: Kolker, 1976.

If the calculated value is less than $r^*(r < r^*)$, it Fx_i is left in the statistical whole, if $r > r^*$, it is disabled. In this way, all statistical values of the population are checked.

4. AN EMPIRICAL STUDY

According to Eurostat data on the GDP of EU countries in 2018–2022 Table 2 and formulas (8), (9) and (10) were primarily used to calculate the state and intensity of economic development of the countries under consideration (Table 3).

Table 2

GDP of EU countries in 2018–2022

Row No.	Country	Year				
		2018	2019	2020	2021	2022
1	Belgium	40260	41660	39830(p)	43350(p)	46990(p)
2	Bulgaria	8000	8820	8890	10330	12400(p)
3	Czech	19850	21150	20170	22270	25850
4	Denmark	52180	53210	53410	58590	64450
5	Germany	40590	41810(p)	40930(p)	43480(p)	46260(p)
6	Estonia	19660	20960	20670	23640	27170
7	Ireland	67370	72320	75350	86490	98990
8	Greece	16730	17100	15460(p)	17070(p)	19670(p)
9	Spain	25760	26440	2361(p)	25500(p)	27870(p)
10	France	35040	35980	34080	36670(p)	38550(p)
11	Croatia	12890	13680	12470	14730(p)	17130(e)
12	Italy	29580	30080	27940	30230	32390
13	Cyprus	24910	26280	24550	26680(p)	29590(p)
14	Latvia	15130	16040	15920	17850	20710
15	Lithuania	16250	17510	17830	19990	23580
16	Luxembourg	98750	100360	102650	112780	119230(p)
17	Hungary	13920	15000	14140	15870(p)	17580(p)
18	Malta	26740	28110	25550	28940	31890
19	Netherlands	44920	46880	45670	49650(p)	54150(p)
20	Austria	43590	44740	42730	45370	49360
21	Poland	12990	13870	13720	15100	17370(b)
22	Portugal	19950	20840	19470	20870(p)	23290(p)
23	Romania	10580	11560	11440	12610(p)	15010(p)
24	Slovenia	22140	23230	22360	24770	27980
25	Slovakia	16500	17320	17110	18440	19930
26	Finland	42320	43440	43040	45280	48350
27	Sweden	46260	46390	46420	51910	53490

Source: Eurostat, 2022.

Table 3

Economic Development of the European Union Countries 2018–2022 values of condition and intensity indicators

Row No.	Country	Indicators of the state of economic development $\tilde{Q}_{if}$	Indicator of intensity of economic development L_j	Indicator of economic development P_j	Ranking of countries according to their economic development
1	Belgium	43.23	1.07	46.42	9
2	Bulgaria	12.40	1.55	19.22	25
3	Czech	24.6	1.24	30.50	14
4	Denmark	64.45	1.24	79.92	3
5	Germany	44.41	1.09	48.41	8
6	Estonia	27.00	1.37	36.99	10
7	Ireland	96.99	1.44	139.67	2
8	Greece	17.31	1.03	17.83	26
9	Spain	22.57	0.88	19.86	22
10	France	33.92	0.97	32.90	12
11	Croatia	15.93	1.24	19.75	23
12	Italy	27.53	0.93	25.60	18
13	Cyprus	26.93	1.08	29.08	16
14	Latvia	20.50	1.35	27.68	17
15	Lithuania	23.50	1.45	34.08	11
16	Luxembourg	119.23	1.21	144.27	1
17	Hungary	16.53	1.19	19.67	24
18	Malta	28.38	1.06	30.08	15
19	Netherlands	51.98	1.16	60.30	5
20	Austria	48.87	1.12	54.73	6
21	Poland	14.76	1.14	16.83	27
22	Portugal	20.96	1.05	22.00	20
23	Romania	14.86	1.40	20.80	21
24	Slovenia	26.86	1.21	32.50	13
25	Slovakia	19.53	1.18	23.05	19
26	Finland	47.38	1.12	53.07	7
27	Sweden	53.49	1.16	62.05	4

Source: compiled by the author.

According to Table 1 and formula (12), the most economically developed countries – Luxembourg, Ireland and Denmark, as well as Bulgaria – were excluded from the statistical population. The first "without competition" were assigned to the highest, third group of countries of economic development, Bulgaria – to the first. The results of country grouping are given in Table 4.

Table 4 shows that, as expected, the best situation of economic development is in developed EU countries and the worst is in developing countries and Italy. This country is in this group due to a very low-intensity economic development in 2018–2022 period ($L = 1.09$). Four countries (Estonia, Lithuania, France and Slovenia) are in an intermediate position.

Table 4

Economic Development of the European Union Countries 2018–2022 clustering results

Values of the economic development intervals of the countries		
16–31	31–46	46 >
Bulgaria	Estonia	Ireland
Czech Republic	Lithuania	Austria
Greece	France	Belgium
Spain	Slovenia	Denmark
Italy		Luxembourg
Cyprus		Holland
Croatia		Finland
Latvia		Sweden
Poland		Germany
Malta		
Portugal		
Romania		
Slovakia		
Hungary		

Source: compiled by the author.

The obtained results seem to contradict other studies, which found that the developing EU countries develop significantly faster. This discrepancy can be explained by the fact that the state of economic development of the third group of developed countries is on average almost three times higher compared to the first group of developing countries. The obtained results are important for countries to attract foreign investments, the arrival of foreign companies, etc.

CONCLUSIONS

The state of economic development of countries can be reflected in two ways – either based on an indicator that integrates the most important development factors, or by combining the indicators that reflect them into one summarizing measure. Today, the first method is generally used, since in this case it is possible to compare individual countries. Gross domestic product per capita is taken as such indicator. The second method of assessing the state of economic development is limited, usually determining the situation of an individual country. This is because the applied indicator systems differ in both their number and structure.

The presentation of the state of the country's economic development in terms of GDP at the end of the year is one-sided, as it does not assess both the scale, nature and intensity of the development changes that took place during the considered period. In order to adequately assess the current situation, the indicator reflecting economic development needs to be transformed in such a way that it assesses the extent and condition of both positive and negative development changes. The intensity of development is reflected by the ratio of the value of the transformed indicator at the end and at the beginning of the considered period. The integrated indicator of the country's economic development will be the product of its transformed value $\tilde{Q}_f$ and intensity *r*.

The current common practice of ranking countries according to their state of economic development may give a false impression, since development values do not correlate with ranks, i.e. ranks can vary significantly more than values. This can be avoided by conveying the results of economic development not by ranks, but by homogeneous groups of countries. Such grouping showed that the best situation is in economically developed EU countries and the worst is in developing countries, despite the fact that the development rates of the latter are higher. This situation is explained by the fact that the GDP of developed

countries is almost three times higher compared to developing countries and this has outweighed the impact of development intensity on economic development results.

Further research in this direction may be limited by difficulties related to the possibilities of improving the structure of information on the economic development of countries presented in international databases.

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